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Light-weight scaffold board and method for producing the same

Description

Scaffolding plates, planks, or boards are currently manufactured either from massive wood, sheet steel or aluminum, or profiled steel or aluminum, the attempt having been made for many years, in order to save weight, to lay, insert, fit, rivet, screw, glue, weld, or attach in another way thin plywood plates, which have been made weatherproof, in frames manufactured from profiles instead of the profiled sheet metal over the entire length and width.

In order to then hang the plates in the carrier elements of the rolling or façade scaffolds, which comprise either upright pins or bolts, strips, or round pipes, depending on the scaffolding system, metallic hooks, claws, round grooves, or other suspension fittings are placed, welded, screwed, or attached in another way to the plates or frames.

There are plates in different lengths of approximately 100, 150, 200, 250, 300, and more centimeters and widths of approximately 15, 30, 45, 60, and more centimeters, which then represent the scaffold when hung next to and one behind another in rows in the individual height levels, usually at the height between floors, in the scaffolding construction. In order to be able to climb a scaffold within the construction, different scaffolding plates within the overall construction each receive climb-through openings within the plate, which may be opened and closed as necessary.

To secure the craftsmen and to protect the environment against noise and dust and to avoid accidents, 10 to 15 cm high lateral protection parts, currently made of the same material, preferably wood, at the level of the scaffolding plates, as well as railings at the appropriate height and, if necessary, tarpaulins or nets behind them are attached on the sides of the scaffold construction facing away from the building, which then result in the finished scaffold when considered overall.

Until now, the scaffolding plates, of whatever material, have shared one disadvantage: the craftsmen, who must deal with them daily, consider the plates to be too heavy for laying - particularly at the typical lengths of approximately 250 or 300 cm.

The laying and hanging work is still to be done manually, in spite of the possible transport of the plate stack using cranes and other aids.

Attempts up to this point to use plastic materials such as foams and plates or other compositions and combinations have failed until now either because of the lack of UV and weather resistance, the security of the adhesive bonds applied until now, or the lack of slip safety. The carbolized plywood plates, which are inserted into the plate frames, also do not have a long service life, often rot very rapidly at the connection edges, and thus become a hazard.

Furthermore, the lightweight plastics often have the property of having too low a modulus of elasticity without reinforcement, so that the sag of the plates, which is fixed at one hundredth of the length for safety reasons, at least in Europe, may only be achieved through significant thicknesses of the plates or through costly reinforcements. The low permissible sag of the plates is required because when the plates, which are often very narrow, are laid next to one another, tripping points arise under load, which result in increased danger of accidents.

The attempts to introduce frame constructions made of metal, particularly aluminum alloys, to save weight, have made slight progress, but have not generally provided a breakthrough to a light scaffolding plate.

It is also a problem that there are multiple systems which do not correspond in the suspension and the exact plate lengths, so that manifold plate lengths and widths, plate thicknesses, and types of suspension obstruct the development of new systems and the use of new materials, just like the guidelines of the workers' compensation insurers and the standards. Specifically, until now these have not permitted the use of plastic materials and therefore possibly lower plate thicknesses and greater widths of the plates, having corresponding upward and downward bevels with thinner plate material, so that costly approval processes impair rapid permeation of new developments.

Furthermore, it is also to be noted in regard to the related art that composite plates and methods for their manufacture from various materials, which comprise a support core as a spacer for the upper and lower cover layers, are known. The support core is typically made of foam, honeycomb, caps, boxes, or other webs, positioned linearly or offset,

made of plastic, aluminum, glass, wood or wood fibers, or paper, and the cover layers are made of wood, metal, or duroplastics or thermoplastics with or without reinforcement.

There are also plates which are cold-glued or in the hot gluing or welding method. Thermal bonds of the cover layers to the support core are described in Patents DE 4208812 A1, DE 19533394 A1, and Utility Models DE 20005948 U1 and DE 29809543 U1. The reinforcement of duroplastic and thermoplastic cover layers with reinforcing fibers or fabrics is also known. Even heating elements between the different layers are used for the bonding (WO 01/19937 A1). This also applies for the bonding to boundary profiles, which are placed on the composite plates, the heating wires being embedded in bands made of hot glue or thermoplastic (Utility Model DE 29809542 U1).

Light metal honeycombs are glued into composite plates made of sheet steel or aluminum in one or more layers to manufacture planks for scaffold construction (Utility Model G 9207297.6).

Edge terminuses for composite plates made of thermoplastic are manufactured using hot-press tools by pressing and fusing the upper and lower cover layers and compressing the material in each case into an individual edge (WO 01/19604 A1). These methods are known in the prior art, but are very time-consuming and therefore costly.

As already described, in general heavy planks made of wood or steel, having the appropriate edge reinforcement or protective sheets, which are processed through impregnation, galvanization, and/or lacquering and the attachment of other safety parts, have been used until now as running surfaces in scaffolds because of the prescribed load possibility. Until now, the lateral protection has been mounted in all cases as a separate lateral protection board on the pipe scaffolding.

The use of these materials results in the scaffolding boards being very heavy, complex to transport, and only mountable with significant application of force by humans and machines. The somewhat lighter aluminum scaffolding plates are hardly affordable in regard to price and prone to be stolen. Most of the scaffolding plates used up to this point are specialty waste after they are worn out and are costly to dispose of.

The present invention is therefore concerned both with the weight problem and with the problem of high costs in the development of a novel manufacturing method, which eanbles the advantages of easy moldability of the plastic overall, the light weight

in relation to wood, steel, and aluminum, and, if appropriate materials are used, the combination of as many individuals steps of the production as possible.

With incorporation of Patent Applications DE 102 14 485.0, 102 15 606.9, 102 16 569.6, 102 17 118.1, 102 21 250.3, 102 25 439.7, 102 26 703.0, 102 40 384.8, 103 00 886.1, and 103 00 888.8, a "light scaffolding plate" is thus represented in this description which, by using plastic honeycomb, foam, or web plates or a mixture thereof with welded, reinforced, or non-reinforced cover layers and hot-molded edge terminuses provides a light scaffolding plate which already comprises holders and covering structure, which almost corresponds in price to the typical wood or steel plank plates, and is completely recyclable without problems, since it is largely produced from a single thermoplastic material or from two materials having melting points significantly deviating from one another, wherein the basic raw materials can be reused.

The plastic scaffolding plate, which weighs approximately a third of the weight of the wood or steel plank plate, is easy to transport and mount, already has the lateral protection part, which is to be separately mounted, molded on if necessary, and is permanently UV resistant and weatherproof without further processing or impregnation and is slip-proof and safe to walk on in any weather through the structure embossed in the running surface. A directly molded-on lateral protection part simultaneously additionally contributes significantly to the improved static strength of the scaffolding plate without additional costs, further reduces the transport weight to the construction site, and saves significant additional mounting costs.

As a supplement to the scaffolding plates, typically plates having a climb-through opening are also used, which usually have significantly higher weight than the scaffolding plate, simply because of the frames and the hinges.

According to the present invention, the flap of such a climb-through opening, the frame, and the hinge, which runs on all or part of the length or width of the frame and the flap, are manufactured from the same material by compressing it, the plate in the typical plate thickness, the frame by fusing the plate material and the cover layers into a static folded profile matching the requirements, if a more cost-effective solution comprised of light metal, preferably aluminum frames placed on the edges of the plate or embedded in the plastic, does not suggest itself because of the length of the plate.

The hinge of the plate is also permanently welded in or on through a thermal treatment of plate material with or without reinforcement in or on the cover layers of flap and frame, so that this important climb-through plate is also lightweight and has the same height as the typical scaffolding plate and does not have any localized protrusions as tripping points.

According to the present invention, a revolutionary advantage in relation to typical handling, which saves mounting costs and offers greater safety, particularly in smaller rolling or traveling scaffolds, is also the permanent connection of the four lateral protection parts to the scaffolding board and the incorporation of the climb-through opening into this scaffolding plate. The static values of this frame construction may then additionally be used for the overall statics of such types of scaffolds. The question of drainage arising here is solved through drainage openings introduced into the plate through thermal deformation in the manufacturing procedure.

The plates may be colored permanently and weatherproof in any color. Identifications and company advertisements may be introduced or applied permanently through nonwoven material print embedded in the plastic, through hot embossing occurring in the manufacturing procedure, or simply through subsequent screen printing or tampon printing.

Scaffolding plates, planks, or boards are typically hung directly in the transverse girders of the scaffolds or, at lower thickness, are laid, inserted, or riveted in suspendable frames. Scaffolding plates or scaffolding plate frames, depending on the scaffold type, have either screwed, placed, or welded metal sheets having claws or round grooves for suspension form U-profiles, which are open on top, and from pipes, or metal sheets having perforations for hanging from multiple bolts welded or screwed next to one another on the transverse girders.

Both the massive scaffolding plates made of wood and also lighter plates in perforated sheet steel or aluminum embodiments have, originating from the high material weight of the plate, a weight which requires significant use of energy for the scaffold mounting, particularly for the mounting team, even at half the typical scaffolding width of approximately 30 cm depending on length.

The plate according to the present invention no longer has this main disadvantage, specifically the high weight of each individual plate, even at double plate width, and is usable for any typical scaffold system having the particular specifically molded suspension devices. It is still a disadvantage here that a different type of suspension is required for every system, which results in multiple productions.

This last problem is solved in that the plate is manufactured only in one to two different plate thicknesses and mainly in double or triple the scaffolding plate width of approximately 60 or 90 cm and two to three scaffolding plate lengths having only one single suspension deformation of the plate ends. This suspension deformation, which is realized through compression of the plate material, allows precisely fitted hanging by means of the holes from the pin or bolt system, precisely fitted hanging and clamping with the claws in the U-profile of the claw system, and precisely fitted hanging from the pipe system.

In this case, two typical scaffolding plates currently having approximately 30 cm width because of the high scaffolding plate weight may be combined easily, even at lengths of 250 and 300 cm or more, into a single plate of approximately 60 cm width, or even into significantly larger plates, and these may be compressed in one pass to have a suspension device on the plate ends.

A further advantage is that these plates may be hot pressed in a typical hot press both individually one after another, as well as, at appropriate width of the press, with multiple rows of plates next to one another having the molded universal suspensions in one work cycle, including the upper and lower cover layers and possibly necessary edge terminuses. In this case, even at greater lengths, statically required additional webs may also be welded at the height of the plate thickness within the support core material, so that the entire scaffolding plate is made of a single, homogeneous material.

Furthermore, there are the universal usage possibilities and ability to manufacture in large piece counts, both using plate presses and using double-band presses which have appropriate molds.

Typically, an additional frame of the scaffolding plate may be dispensed with, since it is self-supporting even at greater lengths and matches the statically required conditions, wherein, for this purpose, the structure of the thermoplastic reinforced edge

closures and, if necessary, the insertion of an additional, also reinforced web or even, at large plate lengths, a round, square, or rectangular pipe or U-profile made of the same reinforced material or light metal, at the height of the support core therein or at the edge of the support core as an edge terminus, covering all static requirements and particularly the requirements on the modulus of elasticity.

Furthermore, damage to the scaffolding plate may be repaired easily using the soldering iron and thermoplastic repair material and, if there is a honeycomb as the support core, because of the restriction of damage to a few honeycomb tubes, no danger to the quality or service life of the plate is to be expected.

Providing a light sandwich plate cover layer by laying a perforated metal plate, which is thermally bonded on one or two sides either solely with one or two thermoplastic layers or also with a thermoplastic support core, so that either a perforated plate having thermoplastic cover layer on one or two sides or a complete sandwich plate having perforated plate cover layers on one or two sides, or even thermoplastic cover layers enclosing a perforated plate are produced in one single hot and possibly cold pressing pass, is considered a further novelty in reinforcing the plastic cover layers.

The thermoplastic bonding layers from the honeycomb as the support core to the perforated plate may either be laid in the form of thermoplastic films or plates laid between the support core and the perforated plate or, if the support cores or spacers are closed, may be laid, rolled, scattered, or sprayed in powder form during the production process. The use of honeycomb material which already has during the manufacturing process an upper and lower complete or partial hole covering or broad beads made of thermoplastic material at the hole edges and whose molten volume is used to bond the perforated sheet then to the honeycomb core thermoplastically, is even better. Such honeycombs may be manufactured at the required honeycomb plate thicknesses in the direct extrusion method and may also be included at once in the production process.

With foam material, sufficient material is melted during the hot press process that the permanent bond to the perforated plate is produced. In any case, the procedure results in a light scaffolding plate having one or two perforated metal cover layers or perforated metal layers enclosed by thermoplastic, which have significant load carrying capacity and provide good and sufficient static values together with the support core.

The reason that a permanent bond of the perforated plate is possible through the melting process even without it being enclosed by thermoplastic is the presence of edge depressions toward the hole centers in this case, which, during the fusing process, not only non-positively bond the perforated plate material flat in the hot gluing method, but rather also by enclosing the edge beads around the entire circumference over the beads inward toward projecting perforated plate parts of all holes of the plate, without thermoplastic material being able to or having to exit on the top side of the cover layer, unless complete enclosing of the perforated plate with thermoplastic material is desired.

In this way, it is possible to dimension the thickness of the bonding layer low if necessary and save thermoplastic cover layer material with the height of the perforated plate or with the height of the perforated plate and the projecting edge depression.

The perforated metal cover layers may also receive structures on their surface even during manufacture and may be provided externally with raised or depressed structures during pressing on one or both sides, e.g., even with an anti-slip covering. Furthermore, a colored design may also be produced here through permanent coloration of the thermoplastic material visible through the perforation, or even of the perforated metal plate. Therefore, for example, in the case of with company products, permanent identification is possible, which is good as theft protection and also for advertising purposes.

An interesting solution of the object in the case of the perforated sheet metal solution is laying the desired design or lettering in the desired color as a plastic film or colored nonwoven material, which bonds to the remaining cover layer on the surface upon heating and is visible through the holes.

The openings of the perforated metal plates may have different shapes, such as round holes, oval or box-shaped holes, oblong or square holes, with and without round corners or a mixture thereof, crescent, cross, or diamond shapes, may be positioned in linear or offset rows, diagonally offset rows, or similar way, the relative free hole area making up approximately half of the plate, but also more or less.

With all hole shapes it is possible to manufacture edge depressions or conical edge formations running toward the later support core, so that the thermoplastic material upon the hot pressing lays around the existing beads or hole edges tapered toward the

hole center during the fusing proces and therefore bonds the perforated metal plates to the thermoplastic material immovably and homogeneously in a formfitting way.

Depending on the arrangement of the holes relative to one another, if the hole edge configuration is dispensed with, the bonding of the thermoplastic material from the top cover layer to the cover layer lying below the perforated plate and, via the latter or even directly from the top layer, a thermoplastic bond to the support core is provided via the perforations.

Although the perforated metal plate has a permanent seat through the hole edge formation or within the thermoplastic bonding or cover material, for special strains the bond between perforated plate and thermoplastic may also be optimized by a special treatment of the cover material, for example, using a primer (adhesion promoter) or other roughening treatment even during the rolling procedure, so that even strong bending and impact strains of the light scaffolding plate may be permanently absorbed.

Using the perforated metal plate, which has a high bending strength even at low material thickness and with low weight in the composite, even with low overall panel thickness, peak values may be achieved which otherwise can only be achieved through massive material use having high weights and panel thicknesses.

When the nonpositive bonding of the metal cover layer may be dispensed with in the event of later lower load of the light scaffolding plate, the direct bonding of the metal cover layer, which is primed or provided with an adhesion promoter, to the thermoplastic support core suggests itself. A weatherproof bond also arises here and, if textured sheets are used, the necessary slip safety of the plates may also be achieved, which offers sufficient safety with and without an additional structured plastic layer possibly applied during the pressing procedure. The previously cited deformations of the plates are also possible here.

Further additives in the thermoplastic material of the cover layers, but also the support core, result in properties which the base material does not necessarily have. Additives such as short or long glass fibers, glass balls, talcum, wood flour, wollastonite, zinc oxide, polyester fibers, metal powder, mica, calcium carbonate, and the like result in greater strength, higher modulus of elasticity, and influence the modulus of bending and creep, hardness, dimensional stability in the heat, tearing and tensile strength,

compression resistance, dimensional stability, density, fatigue strength, thermal conductivity, and melting viscosity, reduction of stretching, impact toughness, impact strength when notched, creep tendency, shrinkage, thermal expansion, abrasion resistance, UV and weather resistance, melt flow index, etc.

In this cover layer according to the present invention, the light scaffolding plates may also have lateral parts molded on directly through beveling downward or upward or in another way in any arbitrary length, even having recesses, laterally or all around on top, on the bottom, or on one side on top, and on the other side on the bottom, so that finished products arise either already in the hot pressing process or in a second deformation process.

The static absorption of the load forces is performed in the solution of the object according to the present invention described up to this point primarily through the two cover layers bonded to the support core and their reinforcement and/or the perforated metal sheets via the appropriate dimensioning of the height of the support core. In the prior art, frame plates having thinner floors inserted or placed thereon or the wood planks, this primarily occurs via the dimension of the height of the metal frames or the planks.

Achieving the static object of absorbing the load forces in a thin scaffolding plate without using frames may also be realized, as described according to the present invention, by incorporating the 10 to 15 cm high lateral parts, which are prescribed in scaffolding anyway, as a supporting web on one side and an upward or downward bevel at 5 to 10 cm height on the other side, without the thickness of the plate being expanded unnecessarily for this purpose. The cover and lateral part thicknesses may also be kept very low, which also has an effect on the weight per square meter.

The only problem is the stackability of the plates both for storage and for transport, which is solved not only with upward and downward bevels of lateral protection parts and supporting web, but also in regard to the possible alternative of upward bevels on both sides. In both cases, only a slightly diagonal stacking is necessary in order to produce a vertical stack; transverse storage is also possible without requiring significantly larger areas, since the storage or transport area for the lateral parts is saved.

In addition, the time savings during loading and particularly during scaffold mounting is to be noted, which is not insignificant, so that the handling and mounting costs may be significantly reduced once again.

Accordingly, a significant weight reduction is also achieved. The light scaffolding plate weighs 3.5 kg per running meter of scaffold length at a plate thickness of up to 15 mm, including lateral parts, and only 4.2 kg at a plate thickness of 20 mm, i.e., a reduction to a fraction of the weight in relation to current typical scaffolding plates. This is also true at other dimensions. The weight reduction is even higher considering that the additional lateral protection parts to be transported or mounted are dispensed with.

Since, in addition to the lower lateral protection part, further planks or other protection parts up to a height of 100 cm may be necessary on the side of the plate facing away from the building, it is also possible to mold the lateral protection part up to this height onto the light scaffolding plate, without the ability to stack them suffering because of this. However, it is also possible to place the extension of the lateral protection part in an independent part and attach it removably using securing pins or other securing measures.

This may even be extended in such a way that such a placed lateral protection part shields a large part or the entire side of a complete scaffolding panel facing away from the building. According to the present invention, the light scaffolding plate or parts thereof are made of colorless, thermoplastic material which is transparent to light.

In order to also achieve dust-tight complete coverage, even in the area of the connection points to the next plates, the outer cover layer of the lateral protection part may be equipped with a projecting overlap to the particular neighboring lateral plate, or even upper or lower plate, which is set to elastically and permanently press on the other plate. This is permanently possible with pre-tension using an appropriately oriented and hot-pressed fiberglass-reinforced material such as the plate.

The lateral protection parts and possibly placed lateral parts may particularly also be provided with an inscription permanently introduced in the thermoplastic layer, also for advertising purposes and for identification, whether by printing a nonwoven material or by attaching a hot-pressed structure or something similar as already described.

In addition to the advantages and possible solutions already cited, in addition to the perforated metal sheet solution, there are also types of sheet deformation which provide a tight bond of the thermoplastic bonding or cover layer to the thermoplastic support core. Thus, for example, a metal plate may be provided with longitudinal continuous depressions or beads or may receive hook-like or claw-like shoulders, distributed on the sheet surface, toward the support core by means of efficient welding methods.

It is also possible to provide sheets having thinner material thickness with depressions or beads or other structures and attach C-shaped, L-shaped, or U-shaped beveled webs to the two lateral parts, or to configure these sheets in a pocket-shape and glue closed support cores made of honeycomb or foam having closed pores into these sheet sleeves and subsequently provide both ends with the required suspension fitting such as round grooves, claws, or holes or by deformation in other ways.

In the method for manufacturing the "light scaffolding plate", a special layering must be performed during the hot and cold pressing procedure because of the different properties of the materials, which is reflected in the corresponding patent claims.

Considered overall, the present invention enables, in addition to saving weight-related transport costs, saving significant mounting and handling costs, and a novel type of scaffold planking, securing, and design. The typical dust protection planking using film which is easily damaged and typically usable only a few times or even only once, may also be manufactured more stably and cost-effectively through reusable lateral cover plates.

The "light scaffolding plate" according to the present invention having a perforated metal cover layer particularly becomes a homogeneously bonded plate if complete enclosing of the plate with hole edge depressions, which may be enclosed by the thermoplastic bonding layer, is dispensed with. In this case, in addition to the normal hole edge depressions of a sinkhole perforation or a sinkhole perforation on both sides, lobe holes, slotted bridge holes, projecting holes, or other types of holes in which the thermoplastic material of the cover or bonding layer engages behind the perforated sheet at multiple points without engaging the entire surface of the cover plate, may be applied, in particular in the form of round holes, square holes, or oblong, hexagonal, or polygonal

holes, diamond holes, triangular holes, star-shaped holes, or key holes, having rounded corners or being angled.

The individual openings or holes of the sheets may be applied to the plate or to the strip made of steel, aluminum, or other metal or duroplastic, which is intended for later cutting, through stamping, drilling, milling, sawing, or other cutting, combinations thereof, or even other methods in all possible cell sizes.

In order to manage with a perforated metal plate material which has only a low material thickness, the possibility exists of using thermoplastic plate or film material which has tightly arrayed endless glass fibers across the entire plate length. This material is also usable in multiple layers and, laid alternately in layers longitudinally and transversely, may have identical results as fabric reinforcement.

For the manufacturing of the plates in the plate or band press, for a flexible terminus or a partial depression of the thermoplastic surface in the perforated region to below the sheet upper edge, to produce a structure for slip resistance, for example, the hot press and/or the cold press or a flat plate tool which travels through both presses with the pressed product or is passed through, may be designed with a heat-resistant, rubber-like, compressing and subsequently reexpanding, separable layer over the entire area, which causes the thermoplastic material of the bonding or cover layer to be pressed back in the direction of the bottom of the perforated plate at the perforated points, so that the perforated plate top remains free of material. This also results in a savings in material, in addition to other effects.

A further way of producing the light scaffolding plates from only one single material, both for the cover layers and for the support cores and all required reinforcing and secondary parts, is to use a homogeneous polymer monolith.

A method for manufacturing a homogeneous polymer monolith, in which a structure of oriented polymer fibers is kept at elevated temperature, approximately 5 - 2°C below the melting point, and a part of the polymer is melted and subsequently compressed or compacted within a predefined time window and subsequently cooled back to the ambient temperature by leaving it in air, is disclosed in EP 0531473 B1. These are melt-spun homopolymer or copolymer fibers, which, as the compacted product, then have a density of at least 90% of the original fiber density.

An additional invention is thus possibly dispensing with fiberglass or other reinforcement using similar reinforcement materials or the use of perforated metal sheets as the top covering in light plates, which do not match the thermoplastic main material of the plates and only contribute to stiffening the plate, by using a thermoplastic material specially prepared according to the above-mentioned method. This is performed by using a multilayered thermoplastic material, made of the thermoplastic main material and altered with bidirectional molecular orientation, that provides a significant savings in weight for the cover layers from highly-oriented materially-identical reinforcement elements with the same stiffness and strength as in a fiberglass reinforcement. By dispensing with a non-thermoplastic reinforcement material, absolute recyclability of the entire light plate is provided.

A further savings in weight results at high load strains on the plates even if the perforated metal plates, having pocket-like or similarly depressed holes, are used as rivet-like bonded top coverings or even embedded as simple perforated sheets in the cover layers, even significantly thinner than otherwise required.

Furthermore, the use of this material for the support cores as well, i.e., for the honeycomb, cap, box, or web manufacture, is also novel. In this case, for example, in the honeycomb, the honeycomb cross-section or, in other support components, the spacing of the individual spacing bodies to one another may be doubled to quadrupled, without the carrying capacity of the plate being impaired. It is also possible using this prepared material, whose structure has been changed, to make the material thickness lower and therefore the light plates even lighter while maintaining the typically required dimensions.

By manufacturing the support components such as tubes (also connected into honeycombs), caps, webs or corrugations, boxes, or the like in the deep-drawing or hot-pressing methods, for example, while simultaneously increasing the strength, significant material savings related to weight may be achieved and it is then possible above all, during the further processing of the material into the complete light plate while largely maintaining the necessary deep-drawing or hot-pressing temperature, subsequently to thermally press the cover layers made of the same material with the required pressure on the support core, even without nonwoven material or adhesive intermediate layer, and

simultaneously or subsequently to provide the pressed part with the required structures, e.g., edge closures or a slip-proof structure and fittings, molded from the same material.

The additional thermoplastic material that remains in identical or significantly greater thickness than the material of the actual support body during the deep-drawing or hot-pressing procedure of the tubes, caps, webs or corrugations, boxes, or the like on the top or bottom, is then simultaneously used to reinforce the cover layers and is simultaneously used here in a linear longitudinal or transverse orientation for further, significant improvement of the stiffness and bending resistance and thus makes it possible to achieve an optimum material use, that is favorable in regard to weight and naturally affects the price.

A further consideration according to the present invention is to find a simple and cost-effective method technology, which allows a tight bond of the perforated metal plate to a thermoplastic and a statically active support layer as a support core in a simple way.

In the way described in the following, in one manufacturing pass, the support core, which is comprised either of known thermoplastically deformable plastic honeycombs, tubes, caps, boxes, webs, corrugations, or similar structure plates or even plastic foam plates, is hot pressed directly with one or two perforated sheets without an intermediate layer and cooled under pressure, so that the support core material itself deforms into the shapes required for the tight bond.

All properties which are expected from the cover layer that is visible later, such as color, weather, temperature, and UV resistance, elasticity, tensile and bending properties, as well as thermoplastic deformability under pressure, etc. are already provided here by the thermoplastic support core, which also positively affects the strength and bending properties and particularly the overall weight in large part.

An additional, special property of the perforated metal sheet, specifically the existing sinking or depression of the holes and therefore the possibility of a smooth surface of the cover layer, which then appears made of metal and plastic, is also represented here by the uniform, perfect tight clawing and bond of the sheet metal to the plastic material in the form of multiple rivet heads.

Any final thickness of the light scaffolding plate may be determined through the height of the support core before the pressing step. Inaccuracies and tolerances of the

support core plates are compensated by predefining the final height, as are slight inaccuracies in the flatness of the perforated metal sheets or the burrs formed when perforating. Furthermore, by increasing the height of the support core material, the thickness of the bonding thermoplastic layer and therefore the stiffness and bending strength, i.e., the stability of the finished plate, may be influenced.

Through the permanent inclusion of the metal in the chemically resistant plastic in the perforated region, it is even possible to perform subsequent finishing of the metal at the visible surfaces, such as anodizing in the case of aluminum, so that protecting these surfaces during pressing may also be dispensed with here.

By selecting the hole shapes and sizes and their linear or offset arrangement in the perforated metal sheet and also through the depth of the hole sinking, both the hole sizes of the honeycombs, boxes, or tubes, and the spacing of the webs or caps, etc., in the support core may be taken into consideration completely and a tight, permanently stable bond may always be achieved. The weight of the finished plate may also particularly be tailored to the application, so that optimum results may be achieved in regard to the lightness of the plates.

The light scaffolding plate also has further possible uses as a light plate. It is suitable not only as a scaffolding plate, but rather also as a floor and lining plate and for multiple other plates and supporting profileswhich are loaded in regard to stiffness and bending resistance. Thus, such plates may be used as floor plates, shelves, insulation plates, sound protection plates, and plates for other areas of application, which must withstand static strains and also suffice for decorative purposes.

A further important function may be assumed by the plate as a vacuum panel, by using a gas-permeable support core and a gas-impermeable film which encloses it completely.

Methods for manufacturing the plate have already been discussed at different points of the description. However, the individual method steps will be described once again in the following:

In order to manufacture, in a stationary plate press, the "light scaffolding plate" from a thermoplastic support core or other spacers, which determines the color of the plate, in over-sized thickness and necessary width and length in the middle, over which

only a sheet metal, a perforated sheet metal, or a sinkhole perforated sheet metal is laid on top and bottom, in a single hot-pressing and cold-pressing pass using temperatures for heating and cooling, which are tailored to the different melting points of the materials and the material thicknesses, in direct contact with the hot and subsequently cold plates of the press and/or the possibly required structure, it is necessary to lay the perforated sheet metal on a structured separating film with the sinking of the holes in the direction of the side facing away from the lower press plate and lay the support core thereon in an over-sized thickness. The second perforated sheet metal is then laid on top with the hole sinking in the direction of the support core and pressed with the additional structured separating film laid in the direction of the plate and thermoplastically bonded to the panel, whose later thickness and color design has been previously determined. In the subsequent cold-pressing procedure, the plate receives the final, sunken or raised surface structure and shape and, if corresponding molding tools are used, additional molded parts such as claws, grooves, and other suspension fittings, closures, reinforcements, inserts, and web inclusions, edges, and holes.

When additionally using a thermoplastic cover layer between perforated sheets and support core, the method is analogous with the difference that the support core has a thickness closer to the final thickness of the plate with its cover layers and only the cover layers are placed on top and bottom between the perforated sheet metal or sinkhole perforated sheet and the support core.

To apply inscriptions, prepared lettering and designs, made of plastic film or nonwoven material, or plastic film or nonwoven material which reproduces their colors are additionally laid directly above the lower or below the upper perforated sheet layer or sinkhole perforated sheet layer before the pressing step

In order to press "light scaffolding plates" in multiple units all at once in one pressing pass using a stationary press, these are to be laid next to or one behind another until the entire available pressing area is filled up and are to be hot pressed and cooled simultaneously.

During the hot pressing, the liquid thermoplastic compound generating from the thermoplastic cover layer and/or the surface of the support core flows through the holes of the perforated sheet metal or single perforated sheet metal, the depressions in the plate

are filled, and during the subsequent cooling, the solid rivets or connection pins to the flat plastic layer required for the bodily formfitting bond or the clawing arise.

An improvement of the stability, the modulus of elasticity, and the UV and weather resistance of the plate is influenced by a greater thickness and change of the material properties of the cover layer and/or of the support core and by enlarging or reducing the hole size and/or sinking the holes and/or through offset arrangement of the holes in the direction of the later strain of the scaffolding plate.

To make the manufacturing method more efficient, a continuously running extruding process for the manufacture of the honeycomb support core, with or without flattened plate surface, or a continuously running deep-drawing procedure for a support core in tube, cap, box, web, corrugated, or similar structure is carried out upstream. Furthermore, introducing slots in the honeycomb structure may be carried out upstream. This sequence may be performed in a single, continuously running method with subsequent hot pressing of the cover layers of identical or different thickness from the coil or as a plate in the continuous or plate press cycled method, with or without intermediate layers of nonwoven material, textile, or adhesive layers possibly also from the coil, with or without the application of depressed or raised structures for surface coatings, made of structured separating film positioned or entrained between the materials and the rollers or press plates, such as a slide protection structure, and/or perforated sheet metal or sinkhole perforated sheet metal or similar layers, notching slots, holes, or the like, the subsequent edging and fitting molding and the trimming or cutting to length while maintaining or introducing the required, exactly controlled melting temperature at the surfaces to be fused and material underneath to be fused and subsequent cooling in the subsequent cold press, each under electronic or manual control and precise consideration of the temperature window required for the material.

The manufacture of a "light scaffolding plate" having a fiber-reinforced cover layer is performed in the same way, only the fiber-reinforced thermoplastic cover layer being introduced instead of the normal thermoplastic cover layer and the perforated sheet metal or sinkhole perforated sheet metal being dispensed with.

The identifications of the individual components and functions of the plate in the individual steps of the production method are found in the supplemental pages "on the drawing".

Light-weight scaffold board and method for producing the same

On the drawing

Figure 1	light plate in section	
	01	top cover layer
	02	support core
	03	lower cover layer
	04	fusing of cover layer/support core
	05	downward bevel of edge terminus
	06	fusing of edge terminus/cover layer
Figure 2	perforated metal sheet top covering (sections)	
	11	visible surface of the perforated metal sheet top covering
	12	perforated metal sheet
	13	sinkhole having hole edge depression
	14	thermoplastic layer, positioned sunk
	15	thermoplastic layer
Figure 3	21	visible surface of the perforated metal sheet top covering
	22	perforated metal sheet
	23	sinkhole having hole edge depression
	24	thermoplastic layer at height of perforated metal sheet surface in one plane
	25	thermoplastic layer
	26	possible slide protection structure
Figure 4	31	visible surface of the perforated metal sheet top covering
	32	perforated metal sheet

	33	hole edge depression on both sides
	34	thermoplastic layer at height of perforated metal sheet surface in one plane
	35	thermoplastic layer positioned depressed
Figure 5	41	top perforated metal sheet
	42	support core
	43	bond of support core to cover layer and enclosed edge depression
	44	bond of support core to cover layer and perforated plate enclosure
	45	bond, similar to flat rivets, of thermoplastic to perforated metal sheet edge depression
	46	possible structure
	47	plate-like surface of the support core
	48	honeycomb web having bead
	49	bottom perforated metal sheet
Figure 6	51	perforated metal sheet
	52	conically tapering narrowing of the hole (pocket)
	53	thermoplastic bonding material
Figure 7	54	perforated metal sheet
	55	hole
	56	thermoplastic bonding material
	57	enclosure with thermoplastic material

Figures 8+ 9 types of perforated metal sheets bonded to thermoplastic

61	section through lobe perforation
62	section through projecting perforation
63	top view of lobe perforation
64	top view of lobed web

	65	top view of projecting perforation
	66	top view of upright projection
	67	offset arrangement of lobe hole lines
	68	lobed web
	69	thermoplastic layer positioned depressed toward web
	70	thermoplastic layer in plane toward upper edge of web or projection
	71	thermoplastic layer hot molded under pressure
	72	upright projection
Figure 10	81	section through slotted bridge perforation
	82	section through slotted bridge
	83	section through perforated sheet surface
	84	thermoplastic layer positioned depressed toward slotted bridge
	85	protruding slotted bridge
	86	thermoplastic material
Figure 11	91	top view of offset slotted bridge arrangement
	92	slotted bridge
	93	perforated metal sheet
	94	section through elevation of slotted bridge

Figure 12 simple light scaffolding plate in construction, section

101	support core
102	top cover layer
103	bottom cover layer
104	edge boundary terminus
105	thermoplastic material having highly-oriented reinforcement elements
106	fusing of boundary terminus

107 structure for slide protection

Figures 13+14

111 fused-on deformation for suspension of scaffolding plate
112 fused-in hole having material compression all around
113 fused-on U-profile
114 material compression

Figures 15+16 scaffolding plate before and after the downward beveling, different thicknesses, section

115 compressed support core
116 compression of the support core in the downward bevel region
117 normal support core thickness
118 final support core compression in the downward bevel region

Figures 17+18 scaffolding plate having four lateral protection parts and climb-through flap, side views, cross-sections

131 lateral protection part upright
132 scaffolding plate
133 boundary terminus
134 climb-through flap open
135 hinge made of thermoplastic material, elastic and returning
136 frame for flap, compressed
137 handle hole
138 drainage slots

Figure 19 top view

141 lateral protection part
142 drainage slots

143 climb-through flap
144 frame for the flap
145 climb-through hole
146 hinge made of thermoplastic material, elastic and returning

Figure 20 suspension fittings, thicker and thinner plate

151 claw
152 round groove
153 perforation
154 top cover layer
155 bottom cover layer
156 support core and spacers for cover layer
157 pressure fusing with cover layer
158 deformation of support core and cover layers into homogeneous claw
159 deformation of support core and bottom cover layer into round groove
160 slip-proof structure
161 perpendicular arrangement of the claw
162 angling of the web of the claw
163 deformation of the claw to support the pipe suspension

Figure 21 scaffolding plates having upward and downward bevels, view of plate end of thin plate before stacking, thick plate after stacking

171 suspension claw or groove
172 stackability
173 displacement guard
174 upward bevel lateral protection part
175 downward bevel lateral part

176 cover surface upper edge

Figure 22 rear lateral part, view

177 suspension claw

178 displacement guard

179 upward bevel lateral protection part

180 cover surface upper edge

front lateral protection part, view

181 suspension claw

182 upward bevel lateral protection part

183 cover surface upper edge

Figures 23+24 light scaffolding plate, special forms

plate structure having cover layer on both sides

191 support core

192 top cover layer

193 bottom cover layer

194 highly-oriented thermoplastic material

195 edge boundary terminus

196 structure sunk

197 printed nonwoven material, colored film

plate structure having cover layer on one side

201 support core

202 top cover layer

203 highly-oriented thermoplastic material

204 boundary terminus having slightly rounded corners

205 structure raised

206 inserted reinforcement pipe

Figures 25-28 types of edge terminus

207 tongue and groove

208 positive rounding

209 negative rounding

210 slotting

211 alternating plate thicknesses in the plate

212 U-profiling

Figure 29 double honeycomb plate as the support core

213 honeycomb plate 1

214 honeycomb plate 2

215 connection of the support core plates through fusing/gluing

216 thick cover layer

217 thin cover layer

218 upright structure

Figure 30 light scaffolding plate, top view of latticed molding of claw and round groove part

231 plate A

232 plate B

233 claw on U-profile

234 round groove on pipe

235 top cover layer

236 additional web, also deformed as top layer

237 edge terminus

238 U-profile

239 pipe transverse support

Figure 31 light scaffolding plate, top view of latticed engaging round groove

240 plate A

241 plate B

244 round groove resting on pipe

245 top cover layer

246 edge terminus with extension by additional profile

247 edge terminus

249 pipe transverse support

Figure 32 section through the material to be pressed before the pressing step

with perforated metal sheet

251 top perforated metal sheet having sinkholes

252 support core made of thermoplastic material, such as honeycomb

253 bottom perforated metal sheet of typical type

254 hot and cold pressing plates, stationary or as a band

with simple metal sheet having primer (adhesion promoter)

255 metal cover layer

256 primer (adhesion promoter) applied during rolling procedure of the sheet

257 thermoplastic support core

258 primer (adhesion promoter) applied during rolling procedure of the sheet

259 metal cover layer

Figure 33 section through the "light scaffolding plate", compressed only from perforated metal sheet and support core

260 top perforated metal plastic cover layer with sinkholes

261 support core fused on top and/or bottom

262 bottom perforated metal plastic plate having plastic layer over entire area

Figure 34 surface of the plate having sinkholes before the pressing

263 top perforated metal sheet

264 sinkhole having edge depression

265 for example, honeycomb plate as support core

266 bottom perforated metal sheet

Figure 35 surfaces of the light scaffolding plate

267 smooth plate having plastic layer over entire area without structure

268 structured plate having plastic layer over entire area

269 sinkhole perforated plate having visible metal and plastic layers

Figure 36 different forms of the perforated metal sheet before/after the pressing step longitudinal section through the perforated metal sheet

311 depth of the depression upon perforation at depression depth

312 visible surface of sheet

313 perforation

314 depth of the depression upon further hole sinking

315 hole sinking

Figure 37 cross-section through the perforated metal sheet

321 depth of the depression upon perforation at depression depth
322 visible surface of sheet
323 perforation
324 depth of the depression upon further hole sinking
325 hole sinking

Figure 38 top view of perforated metal sheet with hole sinking and linear bead sinking

331 depth of the depression
332 visible surface of sheet
333 perforation
334 hole sinking

Figure 39 top view of perforated metal sheet having linear depression and additional hole sinking

341 depth of the depression
342 visible surface of sheet
343 perforation
344 hole sinking
345 remaining depression depth

Figure 40 top view of perforated metal sheet having linear depression and hole sinking

351 depression depth
352 visible surface of sheet
353 perforation
354 metal sheet at hole level

Figure 41 surfaces having contours alternately in the metal sheet or in the plastic

361 visible sheet strips
362 visible plastic strips
363 hole contours
364 wave contours
365 corner contours
366 cube contours

Figure 42 front view of light scaffolding plate having lateral protection part and board with openings

371 suspension claw or groove
372 covering surface upper edge
373 lateral protection part
374 groove
375 board
376 opening in board
377 securing pin

Figure 43 light scaffolding plate having combined lateral protection part and plank, view from plate beginning

378 suspension claw or groove
379 displacement guard
380 downward bevel lateral part
381 upward bevel lateral protection part and plank
382 covering surface upper edge

Figure 44 light scaffolding plate having lateral protection part and placed plank, cross-section behind plate beginning

383 upward bevel lateral protection part

384 board

385 securing pin

Figure 45 top view of surface of perforated metal plate having slotted bridge perforations, with thermoplastic filling

391 linear, offset orientation of the slotted bridge perforations

392 supporting sheet part

393 slightly sunk thermoplastic filling, covering bridge

Figure 46 slotted bridge hole longitudinal section and cross-section, after hot pressing, filled up like enclosure with thermoplastic material

411 anchoring of the thermoplastic bonding material over and around the slotted bridge

412 slotted bridge

413 honeycomb support core

414 thermal welded bond to upper honeycomb shoulder

Figure 47 bead-like cover sheet configuration, overturned

421 overturned depression

422 upper edge of sheet

423 bonding layer

424 enclosure of the depression

Figure 48 bulge-like cover sheet configuration

431 bulge

432 upper edge of metal sheet

433 for example, open groove

434 bonding layer

Figure 49 hook-like shoulders on the sheet

441 hook

442 upper edge of sheet

443 bonding layer

444 enclosure of the hook

Figure 50 connection points of the lateral protection and lateral parts with elastic overlap which continues the cover layer and presses on the next plate

451 lateral protection part 1

452 lateral protection part 2

453 upper edge of placed lateral part above lateral protection part 1

454 upper edge of placed lateral part above lateral protection part 2

455 lateral part 3

456 lateral part 4

457 groove for inserting lateral part and lateral protection part

458 elastic overlap pressing on the next plate, welded on the top layer of the lateral part to a lateral edge and on the bottom via the elastic edge engaging in the groove

459 covered seams of lateral protection parts and lateral parts

Figure 51 glued support core

461 L-shaped, C-shaped, or U-shaped downward bevel of the metal cover layer

462 support core made of thermoplastic honeycomb or foam having closed pores

463 thermoplastic layer enclosing the support core

464 adhesive layer between metal cover layer and support core

Figure 52 lateral protection system construction having overlaps to the surrounding scaffolding panels

471 scaffolding panel 471

472 scaffolding panel 472

473 scaffolding panel 473

474 scaffolding panel 474

475 scaffolding panel 475

476 scaffolding panel 476

477 scaffolding panel 477

478 scaffolding panel 478

479 scaffolding panel 479

480 overlap of scaffolding panel 472 to 471

481 overlap of scaffolding panel 472 to 476

482 overlap of scaffolding panel 472 to corner of 475

483 overlap of scaffolding panel 473 to 472, 477 and corner of 476 and etc.

Figure 53 +54 fiberglass layers

496 linear glass fibers laid next to one another, multiple layers oriented longitudinally in thermoplastic plate or film

497 linear glass fibers laid next to one another in thermoplastic plate or film

498 linear glass fibers placed next to one another, longitudinal and transverse layers

499 linear glass fibers laid next to one another, multiple longitudinal and transverse layers one on top of another